Global Climate Change and the Adirondacks

By J. CURT STAGER and MICHAEL R. MARTIN

Most discussion of global climate change occurs on the broad scale, dealing primarily with data that are averaged over very large areas, and most predictions of future climates are based on computer models which are notoriously inaccurate on the local scale. However, such discussion and modeling must also be applied to specific sites using locally relevant observational data if it is to be of much practical use.

Recent speculations in this regard have predicted dire consequences of greenhouse gas-induced global warming in the Adirondacks. Citing projections given in the federally funded New England Regional Assessment (NERA) report, an article in the March/April issue of *Adirondack Life* speculated that autumn foliage will mute to "browns and dull greens" as cold-intolerant oaks and hickories migrate north to replace colorful maples here, and the ski and snowmobile industries will collapse as winter disappears in the face of local warming of as much as 10°F during this century (McKibben, 2002). The NERA report itself shows that coastal areas in the northeastern United States have warmed about three times as much as interior sites have, winter has warmed more than summer overall, and mean annual precipitation has increased since 1895 (NERA, 2001). The report also adds that subsets of this region do not follow the overall trends, with Maine experiencing long-term cooling while Rhode Island and New Hampshire have warmed by 1.7°F since 1895, and it points out the need for more localized study. Unfortunately, NERA fails to treat the Adirondack region separately from the rest of the northeast in its discussion of past and future climates.

Predictions aside, what has really been happening in the Adirondacks during the last century of global-scale warming? The Intergovernmental Panel on Climate Change (IPCC) has summarized global 20th century climatic trends as follows: mean surface temperatures have increased by about 0.6°C (~1°F), mean night-time temperatures have risen by about 0.2°C (~0.4°F) per decade, and continental precipitation has increased by 0.5-1.0% per decade (IPCC, 2001). The 1990's were the northern hemisphere's warmest decade of the past millennium, night-time temperatures have warmed about twice as much as daytime temperatures have, the duration of ice cover on northern hemisphere lakes shrank by 2 weeks during the 20th century, and extreme temperature and precipitation excursions are becoming more frequent. Does the past century of Adirondack climate patterns fit this picture?

In this paper, we present local weather data collected at stations in and around the Adirondack Park between 1926 and 2000 AD. As you will see, key aspects of Adirondack climate have not been following some of the scenarios that are widely presented.

Methods

We examined daily weather records of variable length from eight stations located in Wanakena, Tupper Lake, Lowville, Boonville, Stillwater, Old Forge, Lake Placid, and Indian Lake (Fig. 1; data obtained from the National Climate Data Center). These records generally displayed similar long-term trends in temperature and precipitation between 1950 and 2000 AD, but some sites differed noticeably from the others in sign and/or scale for certain parameters (Fig. 2). No data were available for the southeastern portion of the Park.

We chose the dataset recorded at the State University of New York's

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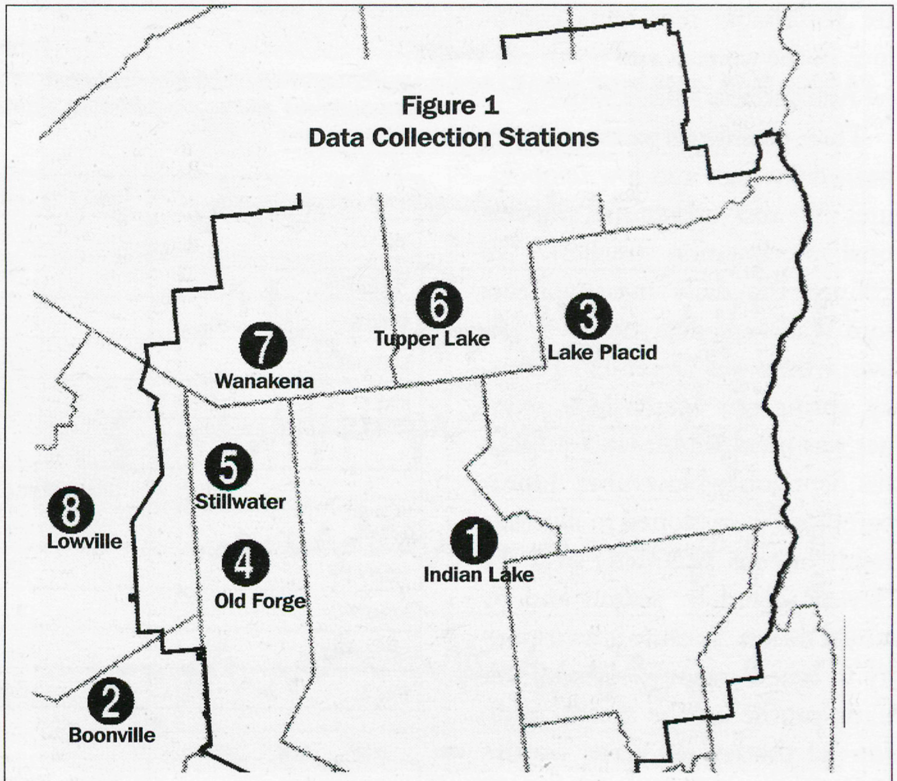
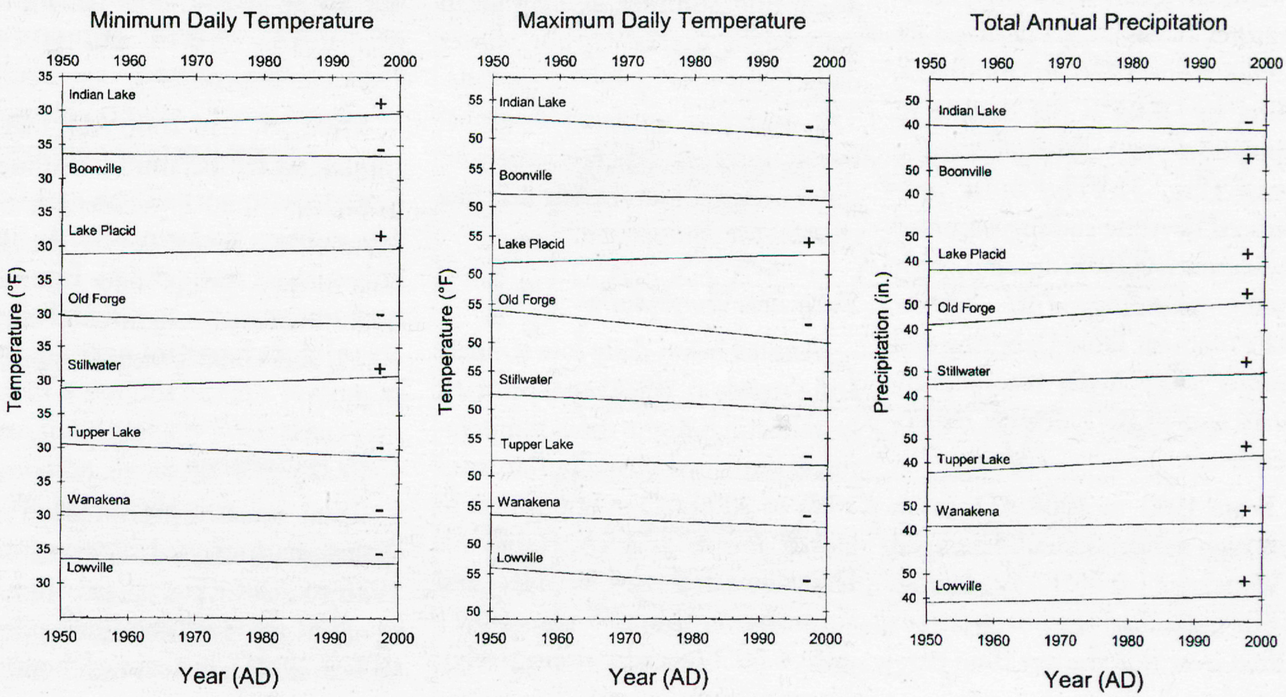
Ranger School in Wanakena, Saint Lawrence County (44°08'N, 74°54'W, elevation 1510 ft.) as the focus of this paper. The Wanakena record is one of the longest, covering 75 years between 1926 and 2000 AD, the magnitudes of its trends are intermediate relative to the other sites, and it was collected in a rural setting where heat island effects are negligible. The Tupper Lake and Indian Lake records come from more central locations in the Park (Fig. 1), but some of the Indian Lake climate trends differ from those at the majority of stations (Fig. 2) and the Tupper Lake records are relatively short and contain large gaps in the daily measurements. The last 50 years of the Wanakena records closely resemble the shorter Tupper Lake records, suggesting that the former

Figure 1
Data Collection Stations



Daily weather records were collected from the National Climate Data Center for eight stations.

Figure 2
Trends in mean daily low and high temperatures and total annual precipitation measured at eight Adirondack stations from 1950 to 2000 AD. The records for some stations were shorter than those from others, so the relatively short 1950-2000 AD interval was chosen in order to compare trends of equal duration from all eight stations.



site reasonably represents conditions in the western and north central Adirondacks since 1926.

Three parameters were examined: mean daily high and low temperatures (°F) and total annual and seasonal precipitation (inches). We grouped the daily measurements from Wanakena into seasons as follows: winter was December-February, spring was March-May, summer was June-August, and autumn was September-November. Linear regressions were plotted to illustrate trends in each parameter over the 75-year record by season and by annual means. Because it is customary to base a region's "normal" climatic profile on the mean conditions of the last 30 years, we also plotted regressions on the last 30 years of the Wanakena records (1971-2000 AD).

Table 1

Summaries of 75 and 30 year trends in maximum and minimum daily temperatures and precipitation at Wanakena, New York by year and by season

	MaxT 75 yr (°F/decade)	Max T 30 yr (°F/decade)
YEAR	-0.04	-0.05
WINTER	-0.02	+0.78
SPRING	+0.14	-0.09
SUMMER	+0.03	-0.12
FALL	-0.20	-0.22

	MinT 75 yr (°F/decade)	MinT 30 yr (°F/decade)
YEAR	+2.9 x 10^{-5}	-0.20
WINTER	-0.11	+0.28
SPRING	+0.14	+0.11
SUMMER	+0.16	+0.05
FALL	-0.09	-0.43

	Precip 75 yr (in/decade)	Precip T 30 yr (in/decade)
YEAR	+0.15	-0.83
WINTER	-0.02	-0.03
SPRING	-0.10	-0.20
SUMMER	+0.18	-0.63
FALL	+0.10	+0.06

Adirondack weather trends since 1926

Daily High Temperatures

Annual mean daily high temperatures at Wanakena declined on average from 1926 to 2000 AD, falling by -0.04°F per decade in opposition to global warming trends (Fig. 3). The most pronounced daytime cooling occurred in autumn (-0.20°F/decade), with weaker cooling in winter (-02°F/decade; Table 1). Spring and summer daily highs rose slightly (+0.14 and +0.03°F/decade, respectively).

From 1971 to 2000 AD, mean daily high temperatures still declined at Wanakena (-0.05°F/decade; Fig. 4) but individual seasonal patterns shifted over this shorter time period. Spring, summer, and fall mean daily highs decreased, but winter daily highs rose by 0.78°F/decade. The degree of similarity to global trends, it seems, depends largely on the time scales and seasons that one chooses for comparison.

Daily Low Temperatures

Annual mean daily low temperature trends at Wanakena, primarily reflecting night-time temperatures, remained virtually flat from 1926 to 2000 AD in opposition to global means (Fig. 5, Table 1). Daily lows decreased in winter and autumn over those 75 years (-0.11 and -0.09°F/decade, respectively), but spring and summer daily lows rose slightly (+0.14 and +0.16°F/decade, respectively).

From 1971 to 2000 AD, mean annual low temperatures continued to decline (-0.20°F/decade; Fig. 6). Autumn lows fell by -0.43°F/decade, but winter, spring, and summer lows increased slightly (+0.28, +0.11, and +0.05°F/decade, respectively).

Daily Precipitation

Total annual precipitation at Wanakena increased slightly from 1926 to 2000 (Fig. 7) as it did in much of the northern hemisphere (IPCC, 2001), but winters became slightly drier overall (-0.02 inches/decade). However, from 1971 to 2000 AD, annual precipitation at Wanakena decreased by -0.83 inches/decade in opposition to global trends (Fig. 8), with only autumn showing an increase (+0.06 in/decade). Most notably, summer precipitation decreased by -0.63 in/decade during those last 30 years.

Summary of 20th century trends

In general, climatic changes in the Adirondacks since 1926 are more or less at odds with global and regional trends presented in the IPCC and NERA reports depending on the time scale examined.

Changes in mean weather conditions at Wanakena since 1926 have not been large. Days cooled slightly and nights became neglibly warmer on average as annual precipitation increased, with the greatest temperature changes occurring in autumn (cooler days) and summer (warmer nights) and the greatest precipitation change occurring in summer (wetter). Winters at Wanakena cooled rather than warmed over the 75 year record, in opposition to global trends.

Mean daytime temperatures at 7 out of 8 Adirondack weather stations fell slightly since 1950, nights cooled slightly at most stations, and precipitation increased slightly at 7 out of 8 stations but at a lower rate than it did globally (Wanakena precipitation increased 0.3% vs. 0.5-1.0% per decade globally).

During the last 30 years of record, Wanakena became cooler and wetter on average and in autumn, but the other three seasons

Figure 3
Wanakena mean daily high temperatures (°F) and trend lines, 1926-2000 AD

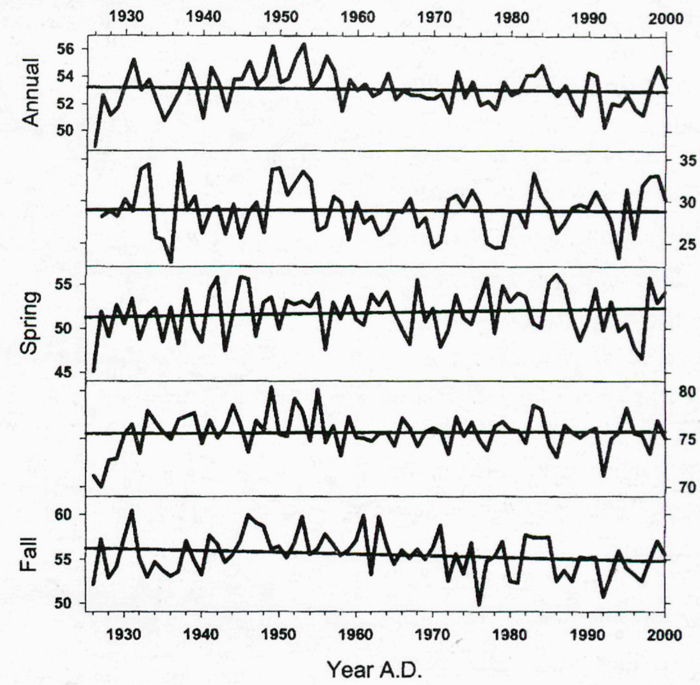
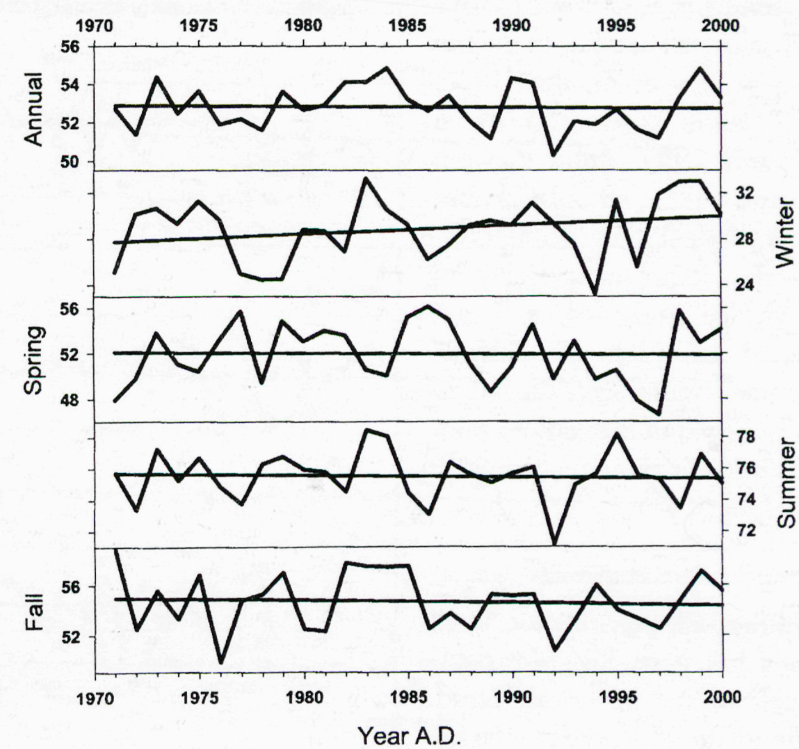


Figure 4
Wanakena mean daily high temperatures (°F) and trend lines, 1971-2000 AD



warmed somewhat. Winter warmed more than summer, as it did on the global average, but winter became drier rather than wetter in opposition to continent-scale trends (IPCC, 2001).

Related trends in Adirondack weather

We further investigated patterns of Adirondack climate change by examining the frequency of extreme weather events at Wanakena and the timing of ice-out on Lower St. Regis Lake in Paul Smiths, New York. The preliminary results of these studies, still in progress, are summarized here.

Extreme summer temperatures

We defined an unusually warm summer as one in which mean daily high temperatures reached or exceeded 90°F for at least 2 days, representing daytime conditions that would be readily noticeable to Park residents and visitors. We found an overall decrease in the frequency of these events since 1926, with 7 warm summers between 1930 and 1955, none between 1955 and 1985, and only 2 warm summers from 1985 to 2000. Lowering the cutoff temperature to 85°F yielded similar results. By our proposed definition, the warmest Adirondack summers of the last 75 years occurred in the early to mid-1950's, with 7 days at or above 90°F in 1953 and 1955.

Extreme precipitation events

Adirondack precipitation in all seasons has been highly variable throughout the historical record. We found no clear trends in the frequencies of extreme precipitation

Figure 5

Wanakena mean daily low temperatures (°F) and trend lines, 1926-2000 AD

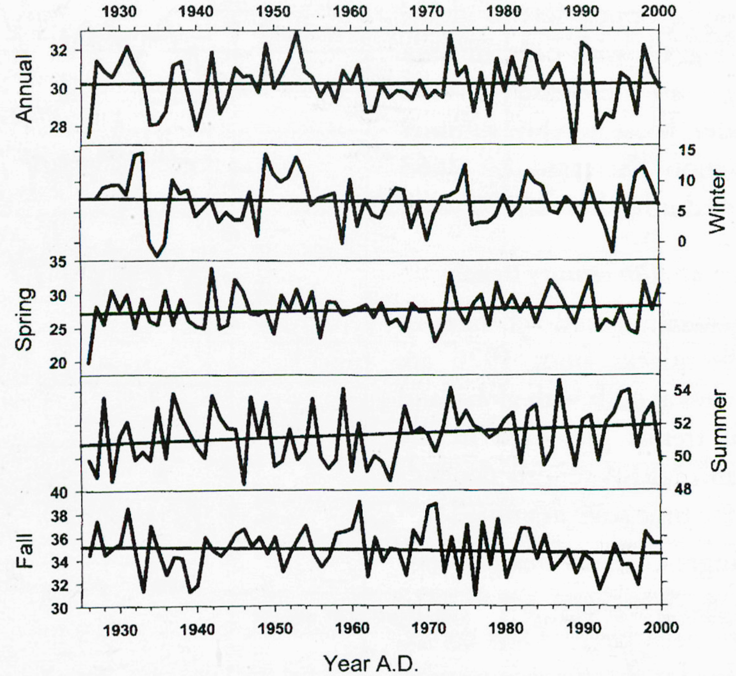
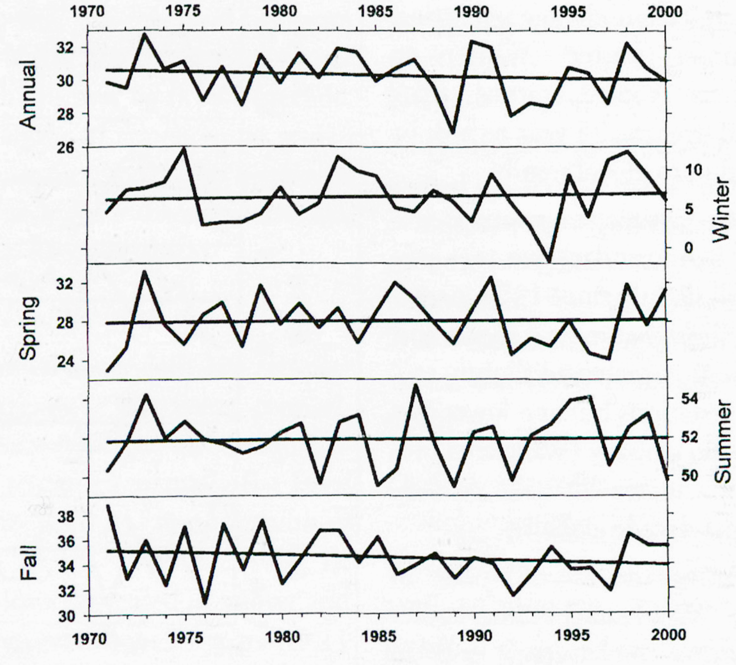


Figure 6

Wanakena mean daily low temperatures (°F) and trend lines, 1971-2000 AD



events over the 75-year period examined, which means that the overall rise in precipitation observed was more likely due to an increased frequency of moderate-scale events than to the number of extremes. The severe ice storm of January, 1998, is sometimes described as a once in a 200-500 year event that may be related to global warming, but major ice storms also occurred in upstate New York and its surroundings during the first half of the 20th century when sparser populations and less reliance on electricity made the impacts on society much less memorable. With such short records, it is difficult to know whether the sporadic temporal distribution of these rare storms reflects a trend or simply the laws of chance.

Lower St. Regis iceout

Iceout dates on Lower St. Regis Lake were measured annually by the library staff at Paul Smith's College between 1970 and 1997 (Ted Mack, personal communication). The mean date for Lower St. Regis Lake iceout is about a week earlier than it was in 1970, which is consistent with northern hemisphere trends (IPCC, 2001). This change may be related to the increasingly mild, dry nature of winters and springs since 1970.

Discussion

The Adirondacks are not following global trends in a simple lockstep fashion. Neither, for that matter, is the United States as a whole; the warmest U.S. temperatures of the 20th century occurred during

Figure 7
Wanakena total precipitation in inches and trend lines, 1926-2000 AD

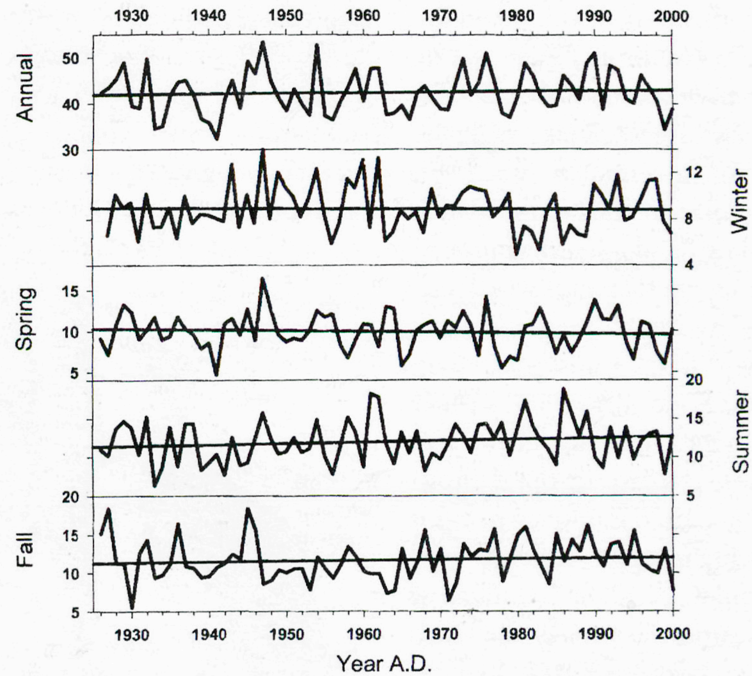
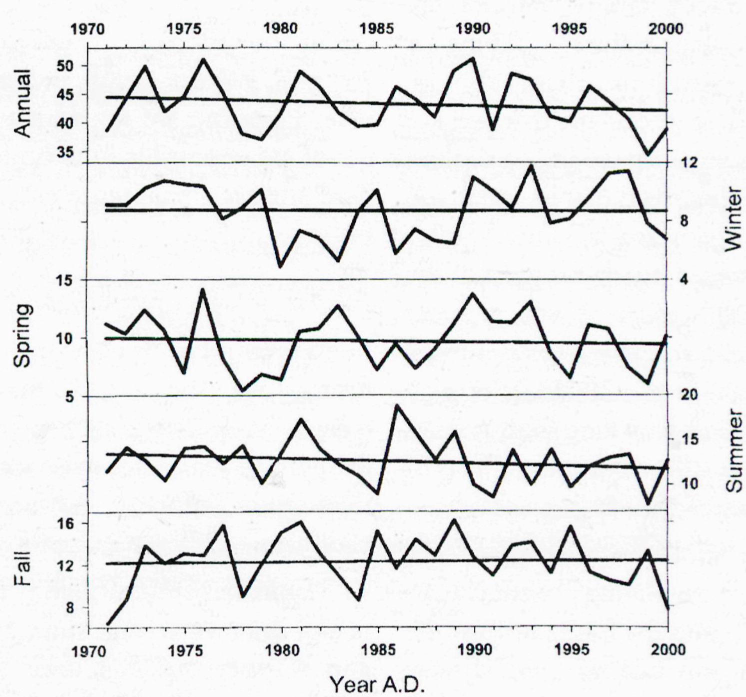


Figure 8
Wanakena total precipitation in inches and trend lines, 1971-2000 AD



the 1930's (Hansen, et al., 1999). This kind of regional inconsistency is to be expected because global means tell little, if anything, about local conditions. Weather conditions in this part of the world are affected by multiple factors, many of them poorly understood and also potentially capable of overriding the effects of greenhouse warming. Among these are the North Atlantic Oscillation and the meandering tracks of westerly winds which can loop southwards to bring cold arctic air down from Canada or loop northwards to bring in warmer southern air. The cause of the precipitation increase in the Adirondacks since 1926 is unknown, but it is probably related to a similar wetting trend that has affected much of North America during the 20th century (NERA, 2001). Possible causal mechanisms behind that trend could involve increased evaporation over the central United States, shifts in the positions of storm tracks, and/or warmer sea surface temperatures. Taking a longer view, one might also be tempted to speculate that we are seeing the continuation of a cooling and wetting trend that has prevailed in the northeastern United States and eastern Canada for most of the last 3,000 years, in which water tables have risen by 10 feet or more (Shuman, et al., 2001). It is anybody's guess how long these natural processes will outpace the effects of human activity.

One should also use great caution in extrapolating present climatic trends into the future because the mechanisms behind local climate variability are still not fully understood. Simply applying global models to Adirondack climates is very risky and it has already led some to conclude that this region has experienced overall warming during the 20th century, which most Adirondack weather stations show it has not. Equally importantly, the time scale from which one extracts weather data greatly influences the trends obtained, as is readily apparent in the differences between the 75- and 30-year trends presented here. How can we say which one out of many possible subsets of this past history best represents the future?

Ruffed Grouse. Drawing by Mike Storey.

Possible climatic effects thus far

Rather than project into the future, we use the Wanakena records to speculate here on how the past 75 years of climate change may have affected Adirondack ecosystems and economies thus far.

Winter has become slightly cooler and drier on average since 1926, and warmer but still drier since 1971: a drying trend of such slight magnitude seems less likely to have hurt the ski and snowmobile industries than the notoriously variable nature of Adirondack snowfall, which wrought havoc on the 1980 Winter Olympics. Prolonged deep snows may reduce deer survival in the Park (Severinghaus, 1972), so the winter drying trend may have favored greater survivorship among Adirondack deer.

Spring has become slightly warmer and drier since 1926, but spring days have cooled slightly while the nights have warmed with continued drying since 1971: the slight warming and drying trend may have ended winter earlier, to the relief of cabin fever victims and the dismay of skiers, and it might also have reduced the size and longevity of vernal pools in which amphibians and mosquitoes breed. Cool, wet springs increase grouse chick mortality by reducing insect food supplies and increasing the risk of hypothermia (Edminster, 1947), so this trend may have favored grouse chick survival. Reduced snow cover may have lowered the volume of acidic snowmelt running into lakes and ponds, which would be beneficial to aquatic organisms. Maple sap collection is aided by warm days and cool nights, so the increasingly cool days and warm nights of spring might have hindered maple syrup and sugar production since 1971.

Summer temperature and precipitation trends have generally resembled those of spring: probably good news for hikers who prefer dry-weather camping and clear views, but these trends may also have resulted in lowered water tables and increased risk of forest fires.

Autumn has become cooler and wetter: these changes may have troubled viewers of fall foliage and increased the risk of hypothermia for hunters, but the probable increased dampness of leaf litter might have made it easier for stalkers to approach their targets.

In conclusion, Adirondack climate patterns of the 20th century can perhaps best be described with a single word: "erratic." In light of the Park's long-term cooling during a century of global warming, there seems to be little value in using projections modeled for the entire planet or for New England when discussing future climate changes here in the Adirondacks. Considering the complexity of local-scale climate and lingering difficulties in modeling it adequately, it is anybody's guess what the future holds.

ACKNOWLEDGEMENTS

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Coalition Offers Three-part Strategy for Sustainable Economic Development

The Northern Forest Alliance has released its latest publication, *Shaping the Northern Forest Economy: Strategies for a Sustainable Future*. This publication features a foreword by author Bill McKibben and is for people seeking sustainable alternatives for the Northern Forest economy. *Shaping the Northern Forest Economy* provides background information on economic trends in the region, and offers a three-part strategy that can help the region create an ecologically and economically sustainable future. It also features examples of local communities and businesses that have started down this path already, as well as recommendations for public policy changes that will help the region make the transition to a more sustainable economy.

The Northern Forest Alliance is a coalition of 43 conservation, recreation and forestry organizations united in their commitment to protect the Northern Forest of Maine, New Hampshire, Vermont and New York. The Alliance's mission is to work together to protect and enhance the ecological and economic sustainability of the natural and human communities in the Northern Forest. Shaping the Northern Forest Economy is the third in a series expressing the Northern Forest Alliance's vision for the region, a vision that incorporates strong local economies, sustainably managed forests, and conserved wildlands.

For a free copy of the publication, call 802-223-5256 x12.